



Vashon – Maury Island Groundwater Flow Model

Phase I Progress Report

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A part of the VMI Water Resources Study

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1/26/05

VMI Phase I GW Model

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Outline of talk

- Purpose of model
- Components of model
- Sources of information
- Process of modeling: calibration, validation, sensitivity analysis, application
- Preliminary results to date

Purpose of model

- Estimate overall **water balance** for island
- Refine estimates (*guesses*) of:
 - **Aquifer properties** & stratigraphy
 - Groundwater elevations & **flow** directions
- Assess **data gaps**, anomalies, investigation needs (monitoring wells)
- Project impacts of water supply stresses

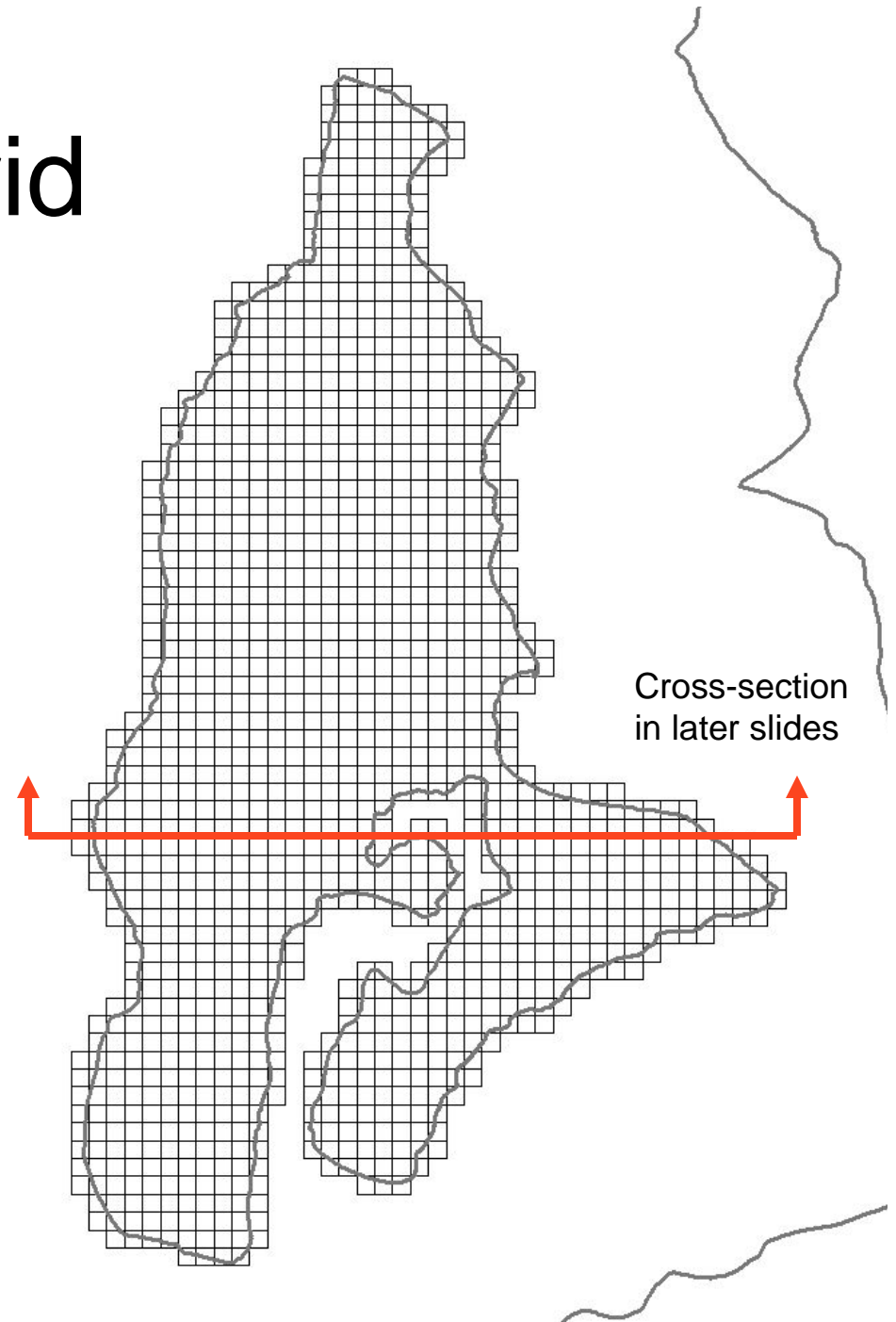
Overall: to test our understanding.

Model components

- Grid and setup
- Hydrostratigraphy, aquifer properties
- Boundary conditions (“BCs”)
 - Wells (“pumping well” BCs)
 - Streams (“river” BCs)
 - Recharge (BC), including OSS
 - Springs (“drain” BCs)
 - Discharge to Puget Sound (“fixed head” BCs)

Grid

- 41 columns, 67 rows
- 1270 active cells per layer (of possible 2747)
- Each cell 1000' x 1000'
- Aligned with 1000' state plane coordinate tics

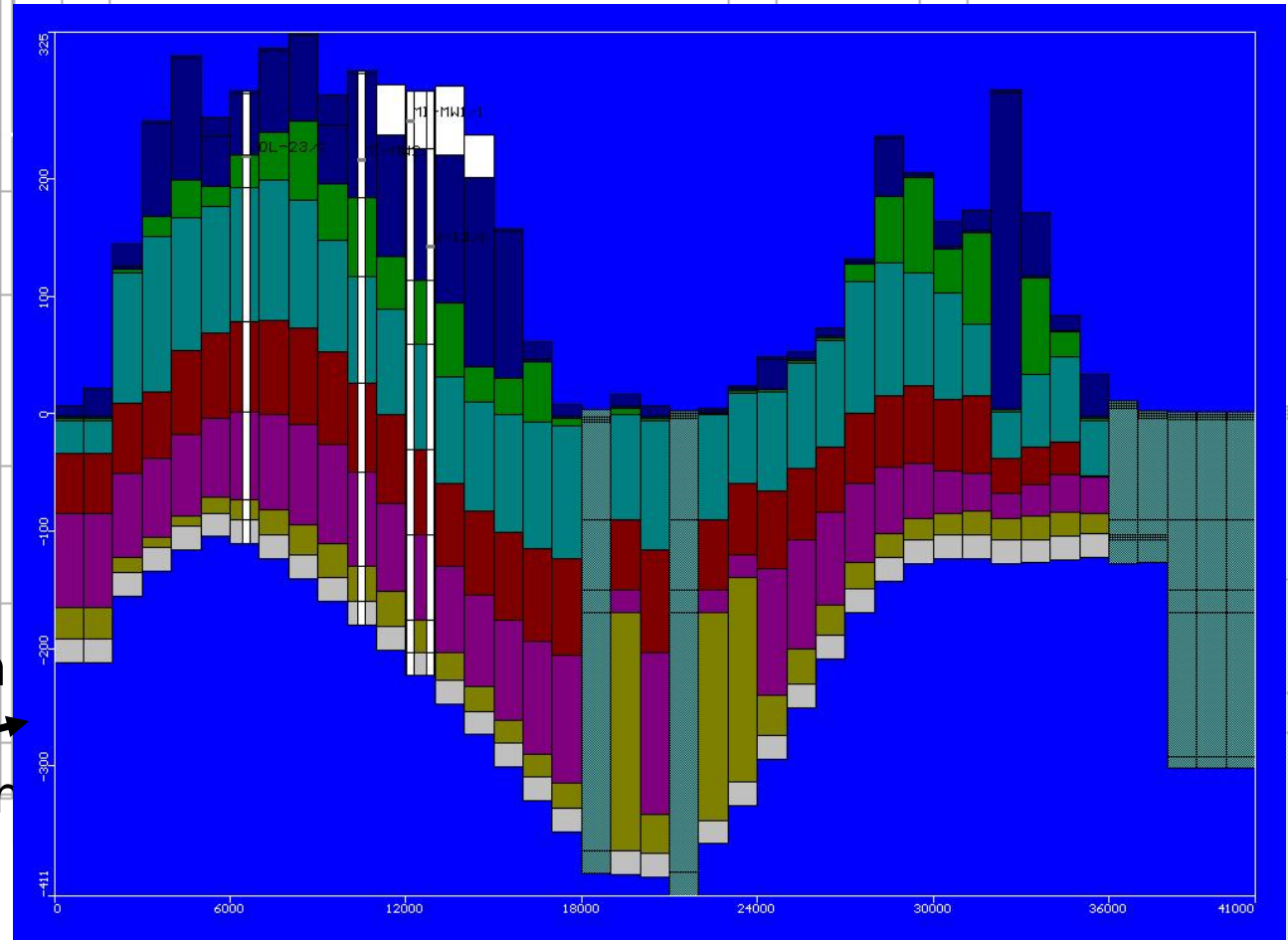


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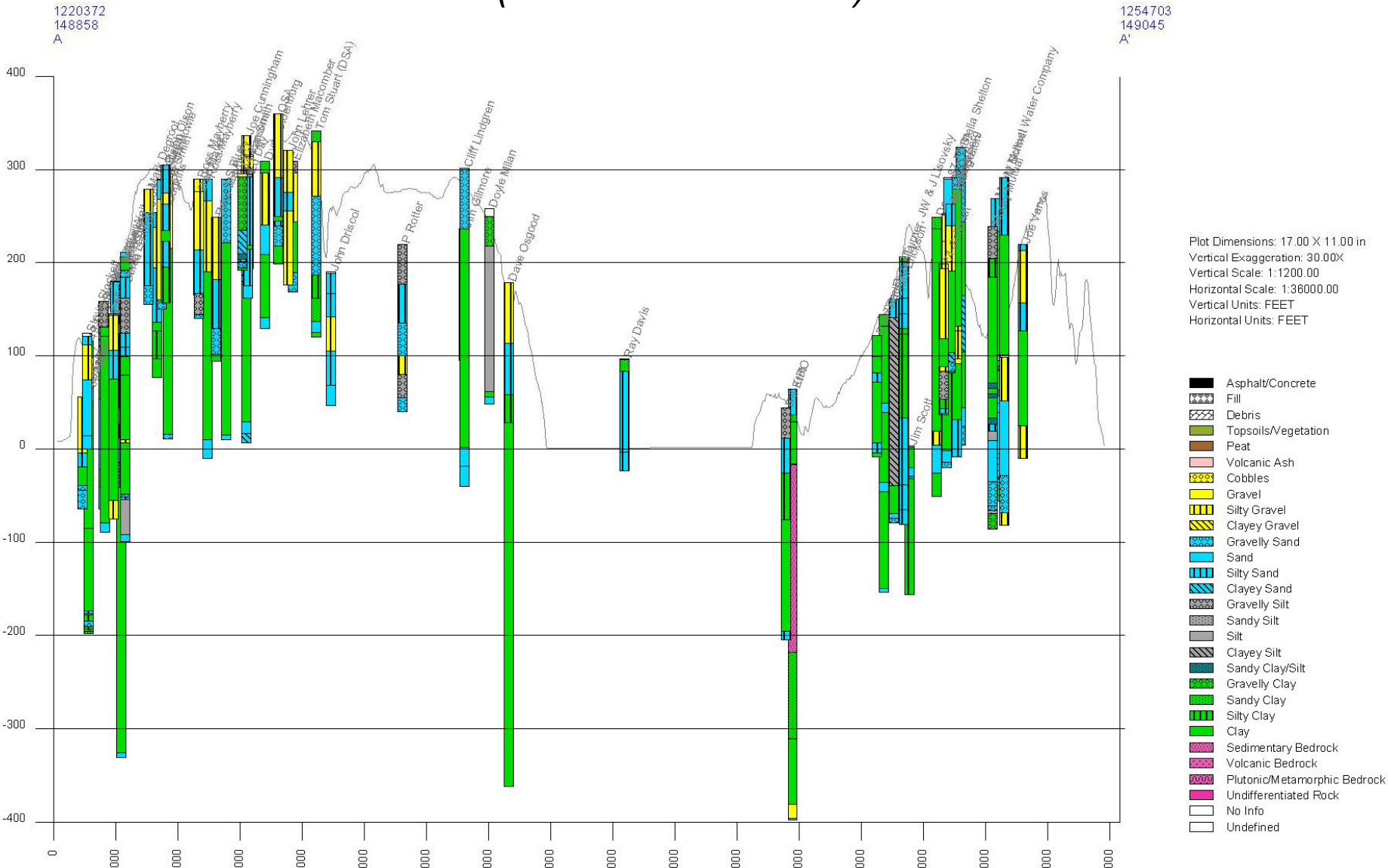
Stratigraphy

- Ground surface from LIDAR
- 8 layers:
 - Qvr
 - Qvt
 - Qva
 - Qpff
 - Q(A)c
 - Q(B)f
 - Q(B)c
 - Q(C) [reserve]
- Base of Qva from UW
- E-W cross section near Burton and Maury



UW database cross-section tool

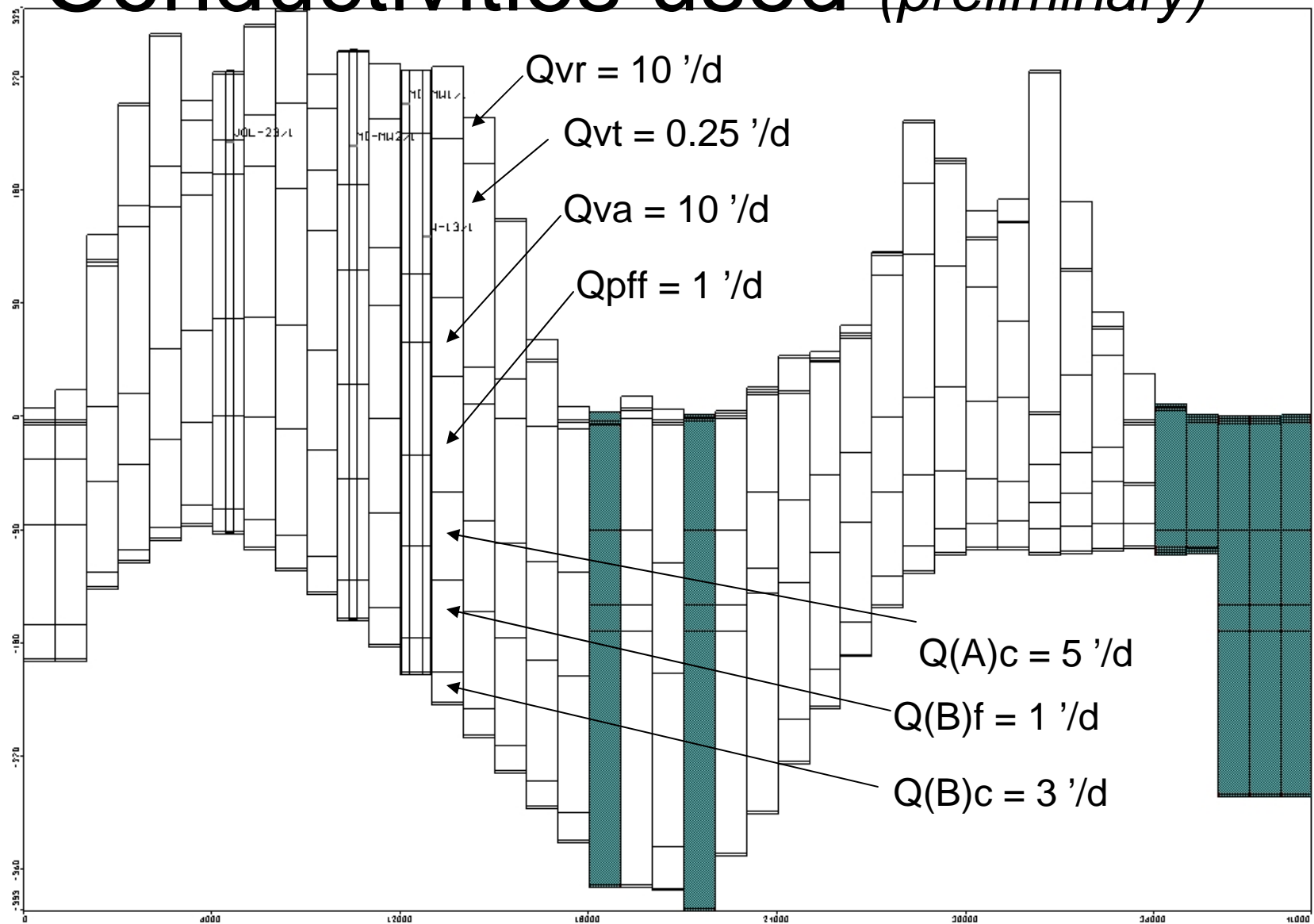
(same cross section)



Aquifer properties

- Major unknown – few pumping tests:
 - KCWD #19 -- Morgan Hill well (AGI '97): 8 ft/d in Qva
 - “ “ -- Gerrior well (AGI '97): ~22 ft/d in Q(A)c
 - “ “ -- Well #2 (Carr '90): 51 ft/d in Q(B)c
 - Heights -- well #3 (Rongey '92): 33 ft/d in Qva
 - Maury Mutual -- well #1 (Carr '90) 23 ft/d in Q(B)c
- Also used specific capacity tests in drillers' logs (bailer, pump tests) – USGS, Ecology method
- Comparable data in other studies in Central Puget Sound glacial units (by USGS, PGG, etc.)

Conductivities used *(preliminary)*

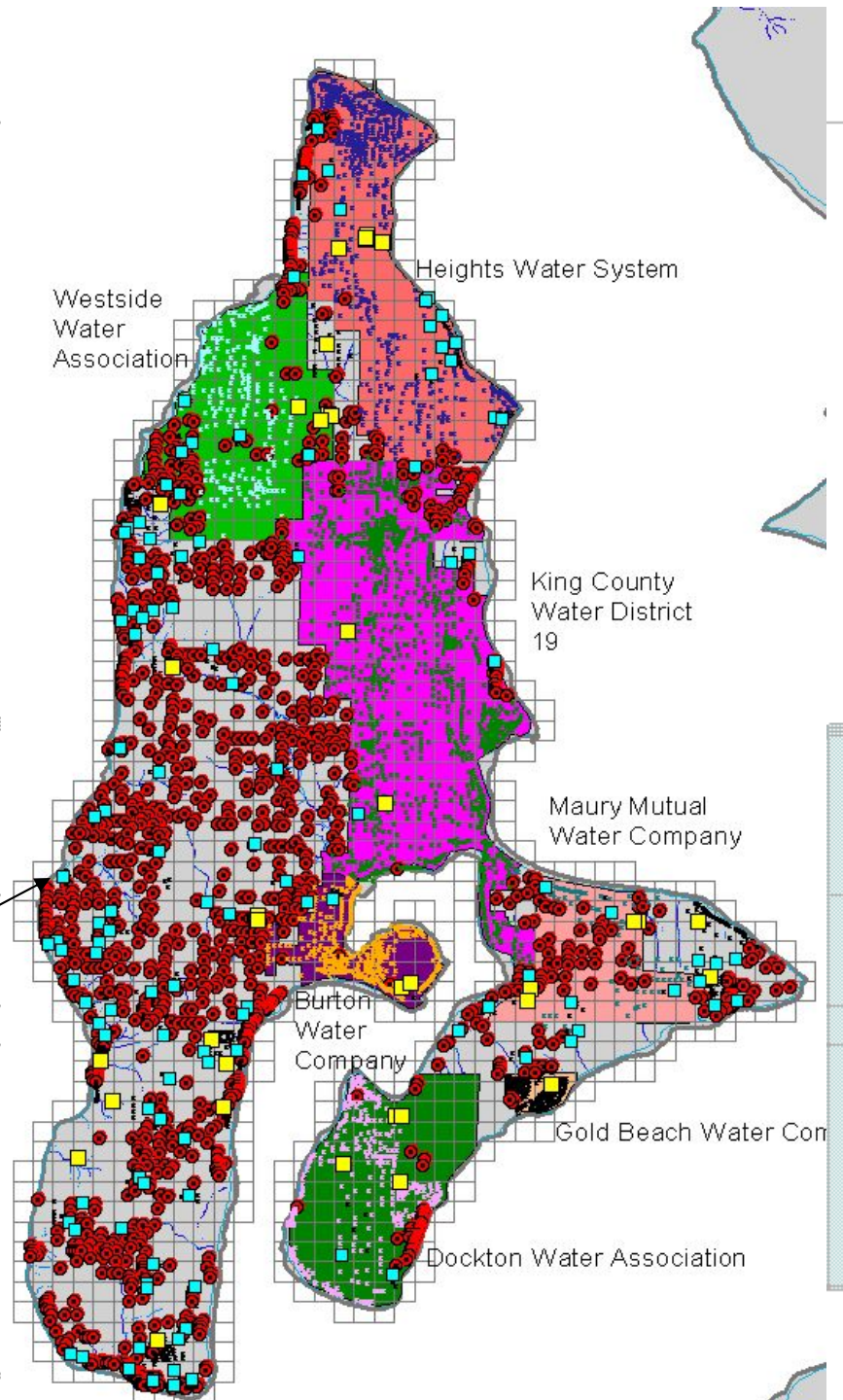


Boundary Condition (BC): Wells

- Group A wells -- purveyor reports / comp plan or Wash DoH (connections x daily rate) – *note: not including springs or WD#19 river intake*
- Group B wells – Public Health database (parcel)
- Individual wells –
 - Compile “improved parcels” & service areas (A, B)
 - Assign to PWSs up to number of connections
 - Remainder of parcels assumed on individual wells
- Depths of wells: DoH/PH databases, individual wells based on UW database
- Have not accounted for agricultural consumption

PWS service
areas (22 As ■,
121 Bs ■)

and
estimated
Individual well
parcels (1276)



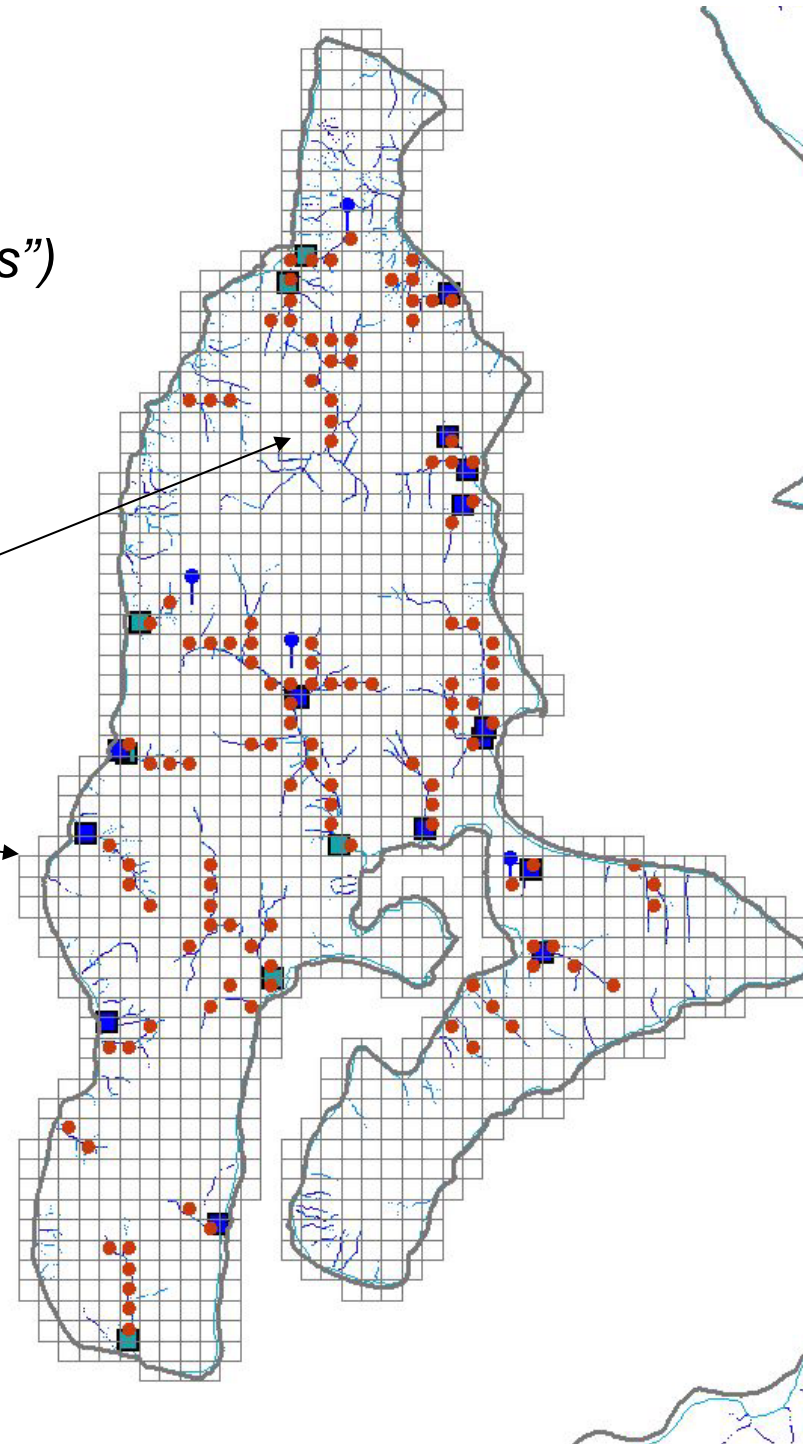
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BC: Rivers

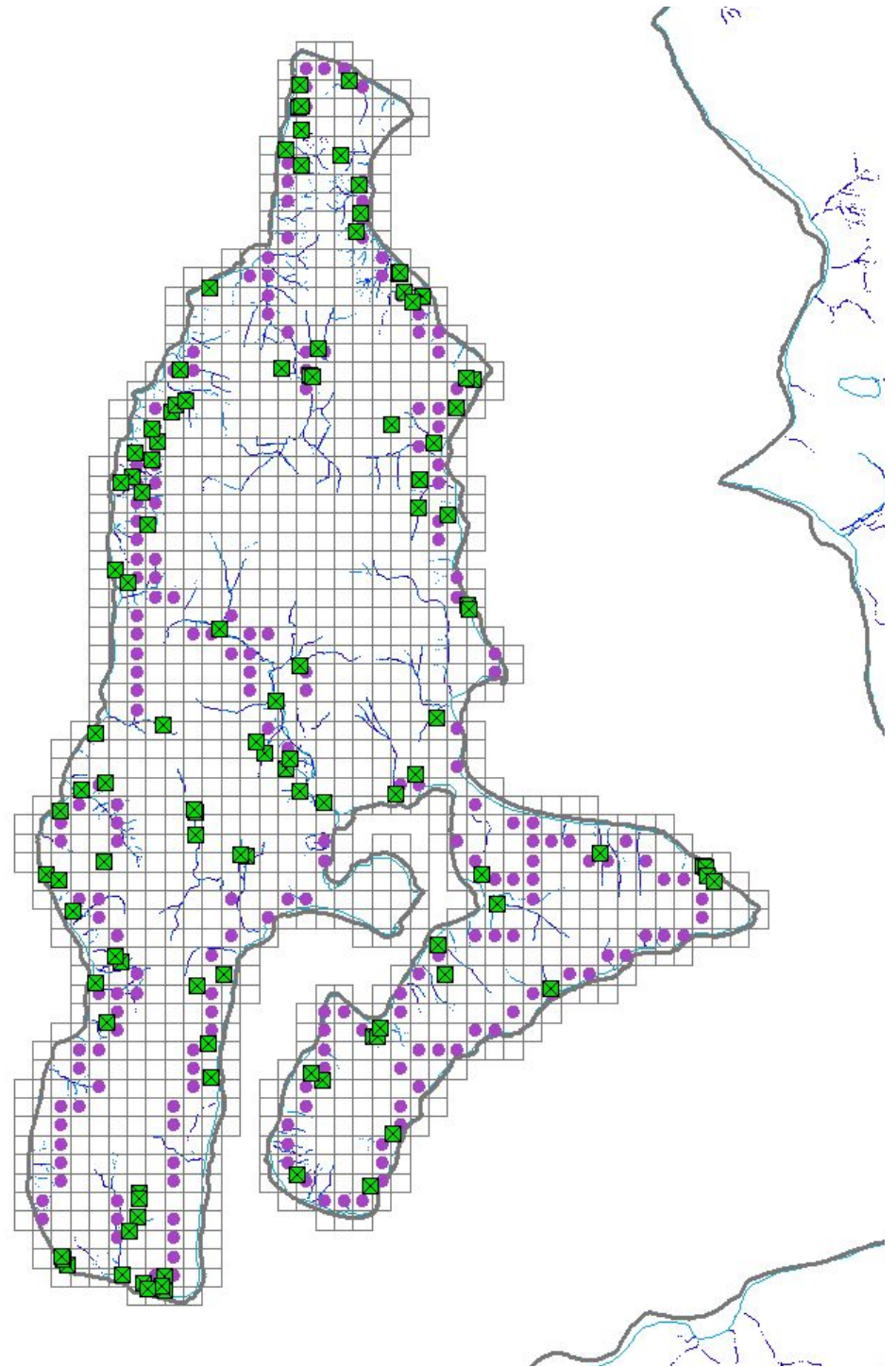
(on VMI they are called “streams”)

- Flows into or out from streams
- Stream / bed levels in cells from LIDAR ●
- Gaging stations allow check to reality ■
- Note: MODFLOW “stream” BC is different



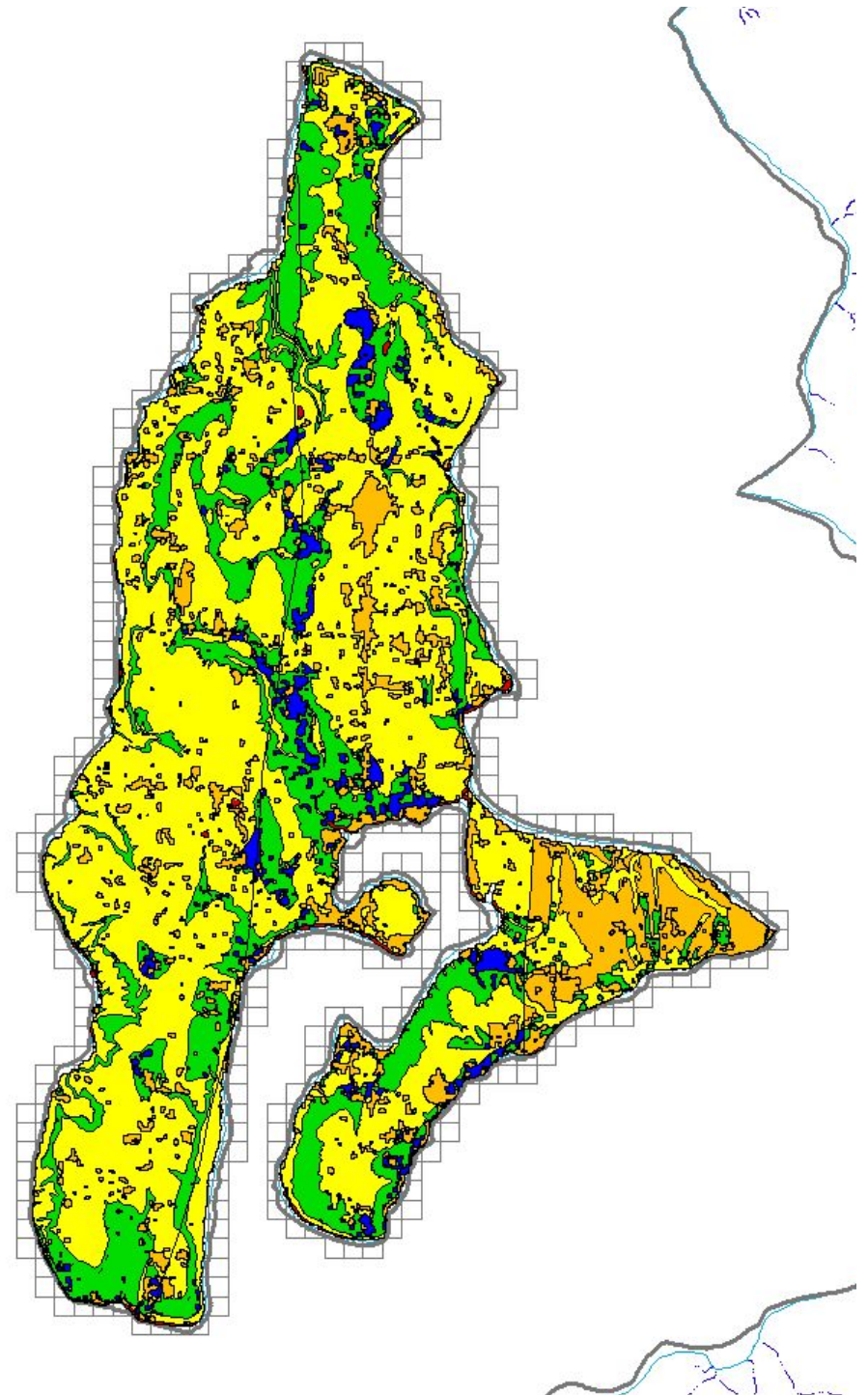
BC: Springs

- Flow out only
- No known compilation of all springs (or flows) to compare
- Locations from Garling et al., Group A systems, Carr, ...
- Currently only from Qva



BC: Recharge

- Flow down from surface
- Estimated using USGS method (Bidlake & Payne)
- Updated from Stephanie Brown estimate using new UW geology
- Value at cell center
- Combined with OSS discharge



BC: Puget Sound Discharge

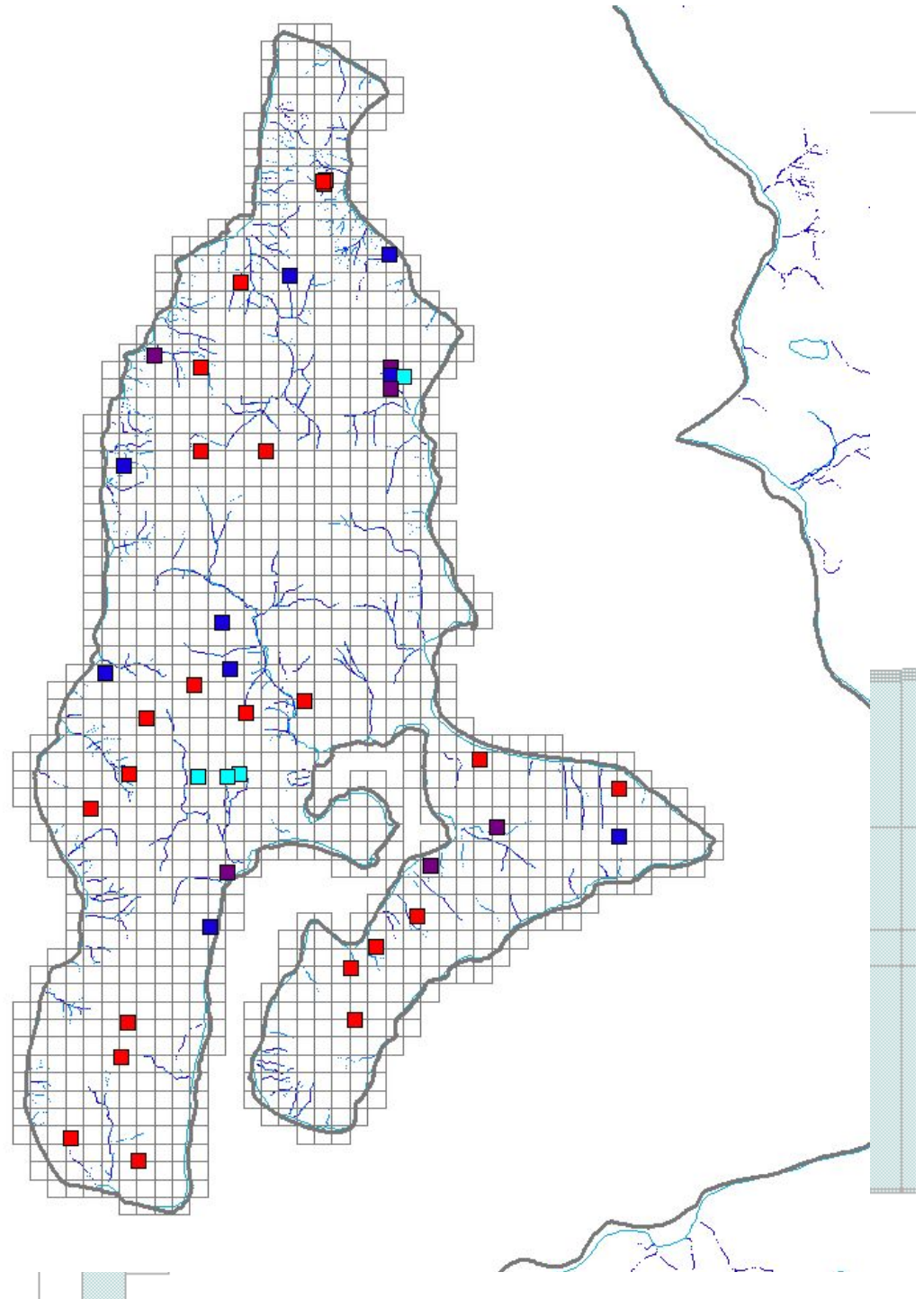
- Groundwater flows to deep zones, springs under Puget Sound
- No data available
- Fixed-head boundary condition (required)
- No consideration (yet) of fresh/salt interface

Process of model operation

- Steady state solution – long-term average recharge, year 2001 pumpage & levels
- Calibrate to *target water levels*
- No separate validation data yet available
- Many options for solving equations to get *convergence*
- Post processing of output
- Successive modification of parameters

Target Water Levels

- Sources:
 - 24 Volunteers
 - 13 Ambient wells
 - 5 Ecology
- 2001 water levels

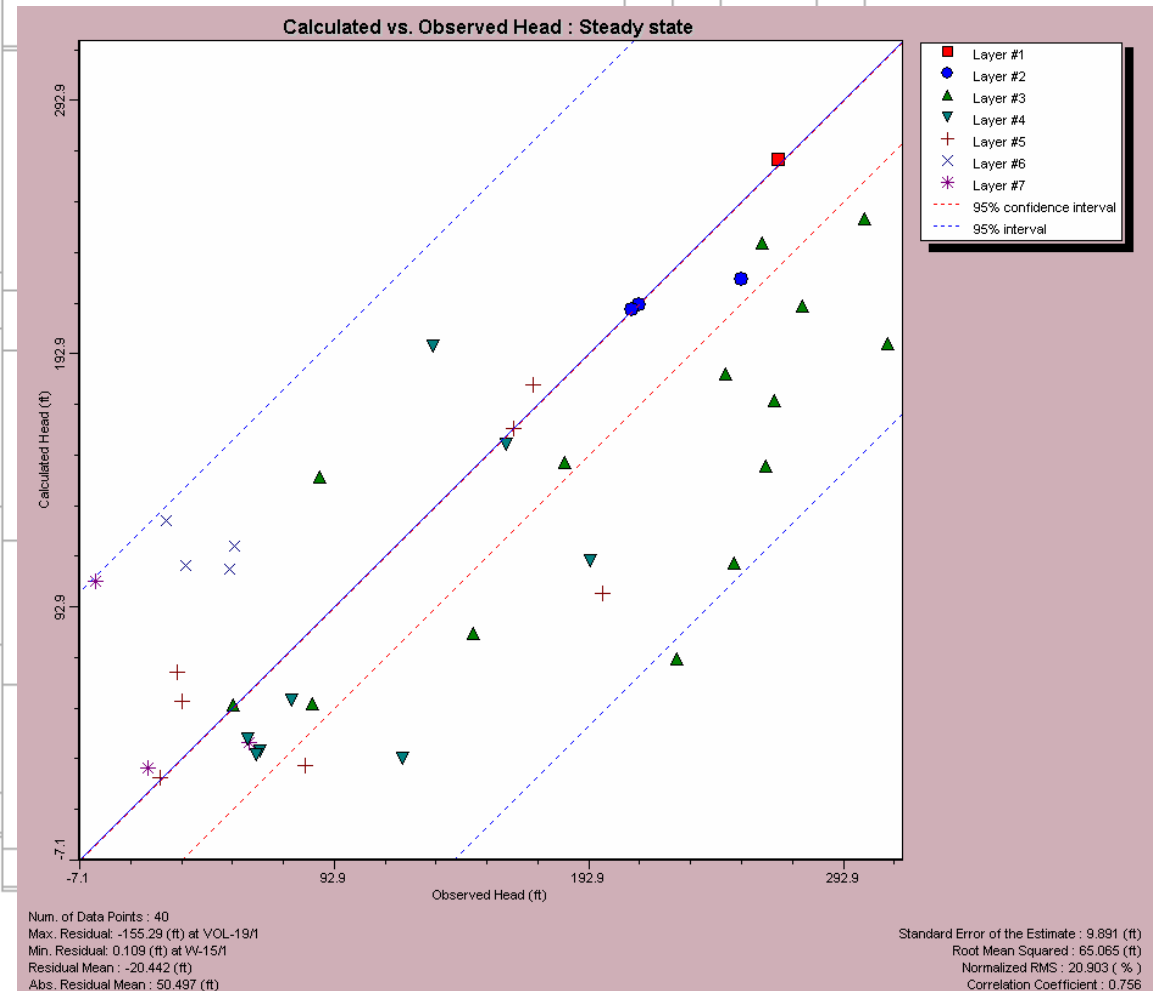


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Calibration results:

Model (calculated) vs Target (observed) Water Levels *preliminary*

- Compare graph (*produced by model*)
- Check fit in each layer
- Modify parameters and retest



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Water Balance (in/yr, entire VMI)

Preliminary

In

Out

- Recharge* +12.9 "/yr

- Rivers*** + 0.1 "/yr

total: +13.0 "/yr

- Puget Sound -10.7 "/yr

- Rivers*** - 1.7 "/yr

- Wells** - 0.4 "/yr

- Springs - 0.1 "/yr

total -13.0 "/yr

* Including: 0.3"/yr from septic systems (OSS),
not including: ET

*** not including: direct runoff

** Including: 0.2 A, 0.04 B, 0.2 indiv;
not including: 0.2 WD19 river, 0.2 A springs

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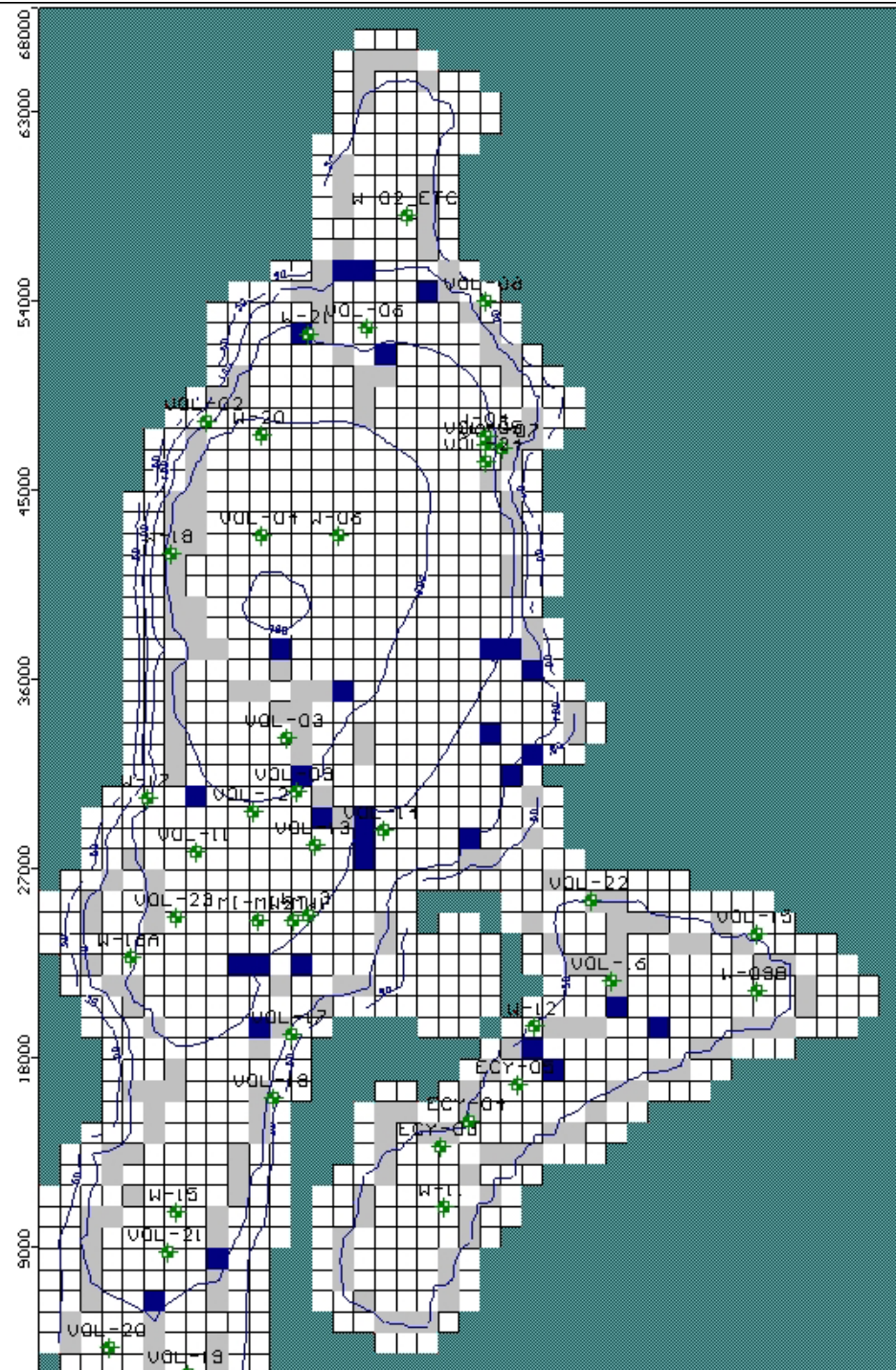
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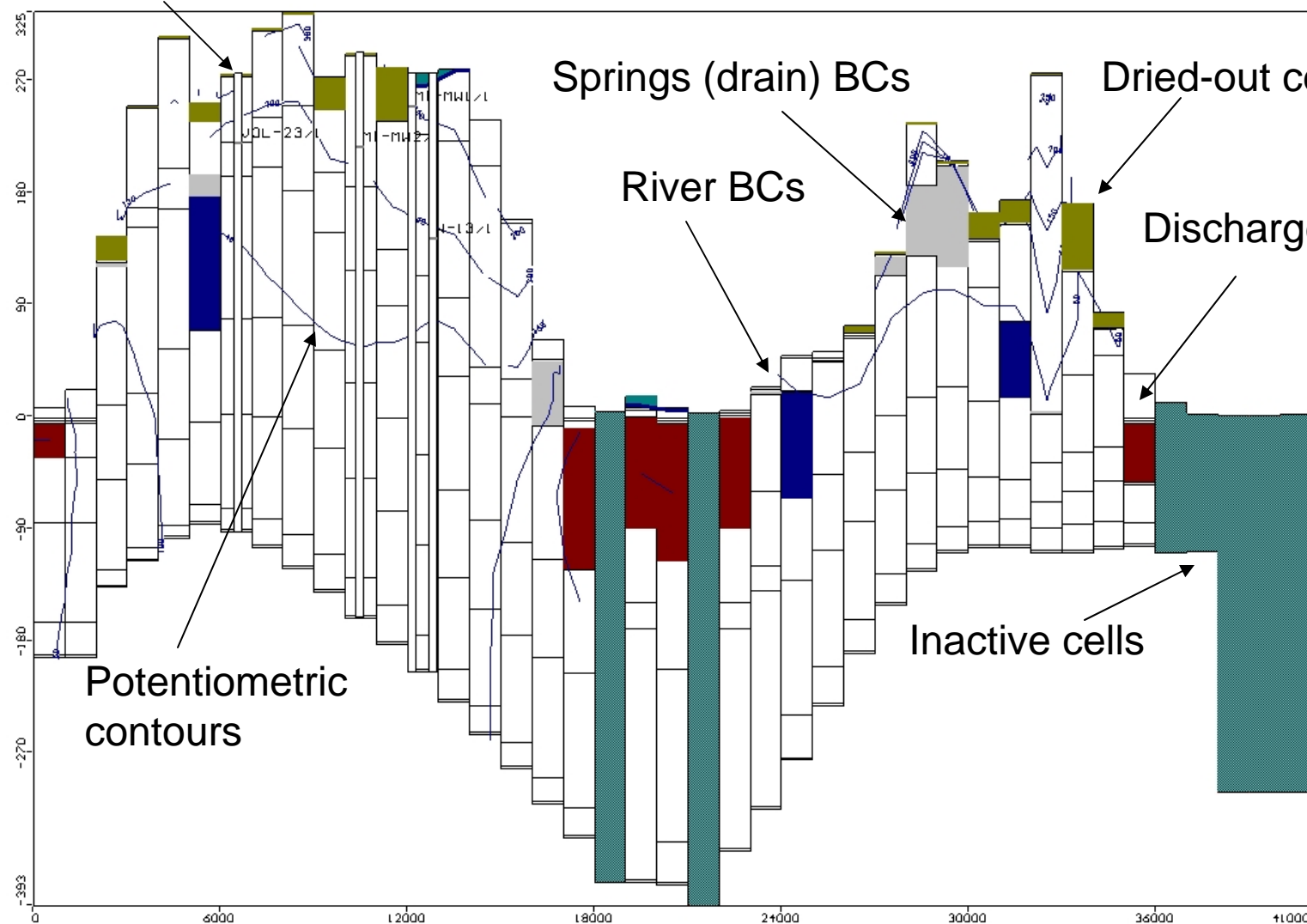
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Water level contour output

- Current run
- Layer 3 (Qva), includes rivers and drains (springs)
- Direct output from model – can generate better contour map

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[illegible]

Dried-out cells

Discharge BCs

Potentiometric contours

Inactive cells



Completion of Calibration

“tweaking”

- Adjust Hydraulic Conductivities
 - By layer
 - Local adjustments?
- Compare with calibration water levels
 - *“better fit”* = tighter correlation & right-on average
- Check against spring locations & flows
- Check with river gaging data
- Compare against known flow directions

Initial Applications of model

- Sensitivity analyses
 - Change of fit / flow system with change of parameters
 - Analyze effects of variations in recharge, pumpage, hydraulic conductivity, ...
- Extrapolate effects on water balance